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TI    Lead-free tin-silver-gold solder alloys
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AB    The title solders are Sn alloys containing Ag 0.5-5.0,
      Au 0.3-10.0, and optionally Cu 0.1-2.0 and/or P or Ga
      ≤0.5 weight%.  The solders prevent Manhattan phenomenon (rising of
      small-size chips being mounted) and segregation in solidification and are
      especially suitable for packaging electronic parts.
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Notes:
1. Untranslatable words are replaced with asterisks (****).
2. Texts in the figures are not translated and shown as it is.

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Dictionary: Last updated 11/10/2006 / Priority: 1. Chemistry / 2. Technical term / 3. JIS (Japan Industrial Standards) term

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FULL CONTENTS

[Claim(s)]
[Claim 1] 0.5 to 5.0 weight % of Ag(s), 0.3 to 10.0 weight % of Au(s), the lead-free soldering alloy characterized by consisting of the remainder Sn.
[Claim 2] The lead-free soldering alloy according to claim 1 with which Cu is added 0.1 to 2.0weight %.
[Claim 3] The lead-free soldering alloy according to claim 1 or 2 with which P or Ga is added 0.5 or less weight %.

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the lead-free soldering alloy used for mounting of electronic parts.
[0002]
[Description of the Prior Art] What contains lead so much is conventionally used for the solder alloy used for mounting of electronic parts. However, in this solder containing lead, lead is eluted from the discarded wiring board, the bad influence and environmental pollution to an ecosystem by this elution lead are being regarded as questionable, and use of the lead-free soldering alloy is demanded. As this lead-free soldering alloy, the Sn-Ag system solder alloy (alloy H alloy), for example, the Sn-3.5Ag (eutectic) and Sn-Bi system, for example, Sn-7.5Bi-2Ag-0.5Cu etc., is known.
[0003]
[Problem(s) to be Solved by the Invention] [in mounting of electronic parts, especially the reflow

method mounting, the heterogeneity of heating of electronic parts is not avoided at the time of soldering, and / a reflow by the above-mentioned Sn-3.5A eutectic solder] Previously, the cream solder of the ** side electrode of electronic parts (chip type) reaches a fusing point, and is liquid-phase-ized. Under the present circumstances, the state where the cream solder of the other side electrodes of electronic parts continues being solid phase arises, electronic parts may stand up with the surface tension by liquid-phase-izing of the cream solder of a ** side electrode, other side electrodes may come floating (what is called a Manhattan phenomenon), and poor soldering may occur.

[0004] On the other hand, with the above-mentioned alloy H solder alloy, a remarkable difference is between solidus temperature and liquidus temperature ([solidus temperature of 185 degrees C]). When the solder by the side of the ** side electrode of the liquidus temperature of 215 degrees C and the above-mentioned chip type electronic parts is in a solid phase state, the solder by the side of other side electrodes will be in a solid-liquid coexistence state (surface tension is smallness from a liquid phase state). Since the difference of the surface tension on which the solder by the side of a ** side electrode acts between two electrodes by being in a solid-liquid coexistence state compared with the case of eutectic solder alloy use can be made small when the solder by the side of other side electrodes is in a liquid phase state, it is advantageous to inhibition of the Manhattan phenomenon.

[0005] However, with the solder alloy containing Bi, it is easy to generate the weak point what is called by a solidifying segregation phenomenon. That is, in the process which solder solidifies, it is the solder portion (usually) of a ****** part. The electronic-parts side solid-phase-izes earlier than the solder portion (usually the substrate side) of a difficulty heat dissipation part. This solid phase portion tends to be stable by Bi deficiency state, Bi is driven into the solder portion side which is still in a liquid phase state as a result, and that liquid phase state portion will be in a state to Bi Rich. As a result of this solidifying segregation, Bi Rich's low-melt point point presentation portion occurs, and moreover, for Bi Rich, this portion is mechanically weak and serves as a thermal and mechanical weak point.

[0006] The purpose of this invention is to offer the lead-free soldering alloy which can prevent the Manhattan phenomenon and solidifying segregation well.

[0007]

[Means for Solving the Problem] The lead-free soldering alloy concerning this invention is composition characterized by consisting of 0.5 to 5.0 weight % of Ag(s), 0.3 to 10.0 weight % of Au (s), and the remainder Sn, can add Cu 0.1 to 2.0weight %, and can add P or Ga 0.5 or less weight %.

[0008] In the solder alloy concerning this invention, toxicity depends the Reason for using Sn as a base material on it being very small, and being able to give the outstanding wettability to a base material, quantity of output being also stable, and it being inexpensive.

[0009] In this invention, the Reason for adding Ag is mechanical strength and for pulling and obtaining improvement in hardness especially, by distributing precisely detailed Ag3Sn which is the intermetallic compound to generate while making the fusing point of solder 232 degrees C or less which is the fusing point of Sn. [the Reason for having made the amount of addition into 0.5 to 5.0 weight %] at less than 0.5 weight %, a fusing point shall be hard to be 232 degrees C or less, if improvement in mechanical strength cannot be attained to satisfaction, either and exceeds 5.0 weight %, liquidus temperature's becoming high too much or a big and rough Ag3Sn needlelike primary phase will carry out crystallization, and a mechanical property, especially elongation characteristics will fall, and they are inside easily.

[0010] [the Reason for adding Au] in this invention It is for making the difference between the liquidus temperature and solidus temperature into a difference of temperature (about 10-20 degrees C) effective in the Manhattan phenomenon prevention, maintaining a solder fusing point at the above-mentioned 232 degrees C or less under coexistence with Above Ag, while making the intermetallic compound of AuSn4 generate and raising mechanical strength. [the Reason for having made the amount of addition into 0.3 to 10.0 weight %] at less than 0.3 weight %, the difference between liquidus temperature and solidus temperature shall be hard to be 10-20 degrees C, if improvement in mechanical strength cannot be attained to satisfaction, either and exceeds 3.5 weight %, liquidus temperature's becoming high too much or a big and rough intermetallic compound will carry out crystallization, and will be extended, and characteristics will fall, and they are inside easily.

[0011] In this invention, the Reason for adding Cu is for raising a mechanical property further according to synergism with Ag and Au, maintaining the fusing point of solder at the above-mentioned 232 degrees C or less. The Reason for having made the amount of addition into 0.1 to 2.0 weight % is that improvement in mechanical strength cannot be attained to satisfaction, about [that liquidus temperature becomes high too much] or a Sn-Cu intermetallic compound is superfluously generated at 2.0 weight % or more, and ductility falls on the contrary at less than 0.1 weight %.

[0012] [the Reason for adding P or Ga] in this invention At the time of solder fusion, these elements oxidize preferentially and prevent oxidation of other elements. It is for not being floated and involved in the fusion solder surface and eliminating the fall of the mechanical strength by oxidation, and the Reason for having made the charge of addition into 0.5 or less weight % is that the embrittlement of about [becoming expensive] and solder is invited by more than this.

[0013] In this invention, it is JIS about elements other than the above. Z You may contain as an impurity within the limits of Class A specified to 3282. (However, Pb 0.10 or less weight %)

[0014] The lead-free soldering alloy concerning this invention can be conveniently used as a solder bath in a Floe process outside the powder solder of the cream solder in the reflow method. The presentations of 65-20 micrometers and cream solder of the grain diameter of this powder solder are usually the powder solder 85 - 93 weight parts, and remainder flux, and the presentations of flux are rosin 20 - 60 weight parts, an activator 0.2 - 5 weight parts, the separation inhibitor (CHIKUSO agent) 3 - 20 weight parts, and the solvent remainder.

[0015] Blow fusion solder on the disk side which carries out a high velocity revolution to manufacture of powder solder, and it is guessed and dispersed in it. The method (centrifugal atomization) and fusion solder to which the rapid solidification of the inert gas is furthermore sprayed and carried out are made dropped from a nozzle, and the method (the atomizing method) of carrying out rapid solidification etc. can be used, spraying and dispersing inert gas there.

[0016] The lead-free soldering alloy concerning this invention can also be used with a rod-like line, the shape of preforming, and the form of resin flux cored solder in addition to the above-mentioned cream solder or a solder bath.

[0017] While the differences of liquidus temperature and solidus temperature are 10 degrees C - 20 degrees C and mounting the lead-free soldering alloy concerning this invention,chip type electronic parts in a wiring board, even if a difference of temperature (even if usually high less than 10 degrees C) produces in the two electrodes of electronic parts In one solder of two electrodes, the solder of the electrode of solid phase state-another side ** A solid-liquid coexistence state, ** In one solder of a solid-liquid coexistence state and ** two electrodes, the solder of the electrode of solid-liquid coexistence state-another side passes through the process of a liquid phase state, both the solder of two electrodes fuses and solder solidifies. Since the difference of the surface tension of the solder which acts between two electrodes since one solder of two electrodes can avoid that the solder of the electrode of solid phase state-another side will be in a liquid phase state can be made small, therefore a couple can be made small, standing up or inclination of electronic parts can be controlled well. Moreover, since addition of Bi etc. is eliminated in spite of enlarging the difference of liquidus temperature and solidus temperature fairly in this way, the development of thermal / mechanical weak point by solidifying segregation can be prevented well. furthermore, the solder itself was excellent -- it pulls, has hardness and ductility and, moreover, mentions later -- as -- copper of a wiring board -- since a joining interface with a conductor also becomes the usual reaction layer of Cu3 Sn/Cu6Sn5 Soldering strong against a thermal shock or a mechanical impact is attained, and mounting of it which was excellent in reliability with a severe service condition like the wiring board for mount is attained.

[0018]

[Example] [Example 1-13] The lead-free soldering of the presentation shown in Table 1 was adjusted. When solidus temperature, liquidus temperature, and a mechanical property (pulling hardness, elongation) were measured about each example article, it was as in Table 1. In addition, a mechanical property is JISZ. The specimen specified to No. 4 of 2201 was adjusted, the load cell type universal testing machine was used and pulled, and it measured with velocity 5 mm/min and the test temperature of 25 degrees C. Moreover, in order to check the existence of solidifying segregation, let the lead of lead type electronic parts pass to the through hole of a substrate. solidifying segregation is not observed, when it solders with each example solder and the section is observed with an SEM photograph -- copper of a substrate -- the interface of a conductor and solder was the normal reaction layer of Cu3 Sn/Cu6Sn5.

[0019] [Comparative example 1-3] The lead-free soldering of the presentation shown in Table 2 was adjusted. When solidus temperature, liquidus temperature, and a mechanical property (pulling hardness, elongation) were measured, it was as in Table 2. Moreover, in order to check the existence of solidifying segregation, when it soldered to the through hole of the substrate with each comparative example solder through the lead of lead type electronic parts and the section was observed with the SEM photograph, Bi Rich's segregation layer was accepted in the substrate side interface with a slow cooling rate. In addition, also in any of the above-mentioned example and a comparative example, it is JIS about impurities other than the element of a presentation. Z It contains within the limits of Class A specified to 3282.

[0020]

[Table 1]

表1

	実施例						
	1	2	3	4	5	6	7
Ｓｎ（重量％）	残	残	残	残	残	残	残
Ａｇ（重量％）	0.5	0.5	0.5	3.5	3.5	3.5	5.0
Ａｕ（重量％）	0.3	5.0	10.0	0.3	5.0	10.0	0.3
Ｃｕ（重量％）	---	---	---	---	---	---	---
固相線温度（℃）	212	212	204	203	204	203	214
液相線温度（℃）	232	224	214	223	217	212	228
引張り強度（kgf/mm²）	5.7	7.4	5.7	6.5	8.4	4.9	6.7
延び（％）	53	54	24	37	29	16	35

	実施例					
	8	9	10	11	12	13
Ｓｎ（重量％）	残	残	残	残	残	残
Ａｇ（重量％）	5.0	5.0	3.5	3.5	3.5	3.5
Ａｕ（重量％）	5.0	10.0	5.0	5.0	5.0	5.0
Ｃｕ（重量％）	---	---	0.1	2.0	---	---
その他（重量％）	---	---	---	---	P0.05	Ga0.1
固相線温度（℃）	206	206	202	202	204	203
液相線温度（℃）	222	215	217	219	217	217
引張り強度（kgf/mm²）	8.8	5.2	8.6	9.2	8.5	8.7
延び（％）	28	17	27	31	26	22

[0021]

[Table 2]

表2

	比較例		
	1	2	3
Sn（重量%）	残	残	残
Ag（重量%）	3.5	2.0	3.4
Au（重量%）	---	---	---
Cu（重量%）	---	0.5	---
その他（重量%）	---	Bi7.5	Bi4.8
固相線温度（℃）	221	185	209
液相線温度（℃）	221	215	221
引張り強度（kgf/mm^2）	4.8	8.3	8.6
延び（%）	47	6	9

[0022]
[Effect of the Invention] In an example article, hardness and elongation are equal to the Sn-Ag eutectic solder of a comparative example 1, and there is no mechanical strength top problem so that clearly from the test result of Table 1. There is no ductility fall which originates in big and rough crystallization of Bi like the comparative example 2 (alloy H solder alloy) of Bi content or a comparative example 3 especially. And since the difference of solidus temperature and liquidus temperature can be fairly made large with 10 degrees C - 20 degrees C unlike eutectic solder like a comparative example 1, the Manhattan phenomenon is prevented and chip type electronic parts can be mounted. Moreover, even if solder is cooled unevenly, there is also no development of week POINTO by the solidifying segregation seen with Bi content solder like a comparative example 2 or a comparative example 3. furthermore, it is based on copper addition from examples 10 and 11 -- it pulls and improvement in hardness is also distinct.

[0023] Therefore, according to the lead-free soldering concerning this invention, electronic parts can be mounted by the hardness excellent in the wiring board for the hardness which was excellent in the solder itself, and the outstanding joining interface hardness, and mounting with high reliability according to lead-free soldering also in the basis of severe thermal / mechanical operating condition is attained.

[Translation done.]